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f the applicant is a corporate body, give the ountry/state of its incorporation

itle of the invention — **MILKING EQUIPMENT**

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MILKING EQUIPMENT

The present invention relates to milking equipment and, more particularly, to devices and methods for improving control of the milking process and the disinfecting and cleaning of teats and teat cups post milking.

Conventionally, automatic milking equipment installed in a milking parlor comprises a milking point at each animal stall within the parlor. Each milking point includes a milking cluster of teat cups for connecting the equipment to the teats of an animal to be milked. In the case of cows, for example, each milking cluster has four teat cups. Each teat cup comprises a hollow shell supporting a flexible liner which, at the upper end of the cup, has a head portion with an opening through which a teat is engaged with the liner. At the opposite, discharge end of the teat cup, the liner communicates with a flexible short milk tube connected to a, so called, clawpiece of the cluster where the milk extracted from the animals teats is collected in a clawpiece collection chamber and delivered, via a flexible, long milk tube, to the collection chamber of the equipment. The milk discharged from the teats is withdrawn from the cups, via the short milk tubes, the clawpiece and the long milk tube, under the action of vacuum applied to the long milk tube.

Milking is achieved by applying pneumatic pulses to the space between the shell and the liner of each teat cup in order to flex the liner and stimulate discharge of milk from the engaged teat. These pulses are produced by automatically and alternately applying vacuum and atmospheric pressure pulses to the space in the teat cup. The clawpiece includes a distributor for distributing the pneumatic pulses to the individual teat cups, via flexible pneumatic lines, as well as for distributing disinfectant and other treatment fluid, water, compressed air and vacuum to the individual teat cups for the purposes of cleansing the teats and teat cups.

Problems can arise during the milking cycle owing to the presence, within the liner of a teat cup, of an excessive amount of the vacuum used to withdraw, from the cup, milk discharged from the teat. This situation may arise because of the non-uniform nature of animal's teats. Precise liner selection for individual

animals is impractical. Excess vacuum in the head of a liner risks the liner creeping up the animal's teat, resulting in restriction of the blood flow within the teat and consequent discomfort, poor milk let down and physical damage to the teat end.

An object of the present invention is to alleviate the risk of excess vacuum occurring within the head of the liner of a teat cup and, hence, the problems associated therewith.

From one aspect, therefore, the invention consists in a teat cup for milking equipment, wherein the teat cup has nozzle means disposed within the head of the cup and connectable to an air supply for admitting air into the head of the teat cup liner, when engaged with a teat, to control the level of vacuum present within the liner during the milking cycle.

Preferably, the nozzle means is connectable with ambient air at atmospheric pressure via control valve means which is adapted to open in response to the vacuum in the head of the liner exceeding a predetermined level to admit the ambient air to the liner, whereby to control the level of the vacuum present within the liner head during the milking cycle.

Conveniently, the control valve means is a spring controlled non-return valve which has its inlet connected to ambient atmospheric pressure and its outlet connected to the nozzle means and which is adapted to open in response to the differential pressure between the inlet and outlet exceeding a predetermined amount.

The invention enables the control of the degree of vacuum within the head of the liner during the milking cycle and enables the milking cycle to be enhanced by alleviating the problems associated with excess vacuum which may occur within the liner owing to the vacuum applied thereto for withdrawing the milk. The regulation of the vacuum present within the head of the liner [illegible]

To reduce the risk of contaminating the milk, the air supplied to the nozzle means and admitted to the head of the liner is clean filtered air. Preferably, it is treated prior to introduction into the head of the liner by filtering it through a food grade filtration system to reduce the risk of contamination.

In a preferred embodiment the teat cup embodying the invention is constructed as disclosed in my copending patent application No 0324647.7. The injection nozzle and associated fluid supply tube described in that patent application for injecting disinfectant and conditioner into the head of the liner during the cleansing cycle, which is initiated at the end of the milking cycle, are alternatively used in accordance with the present invention for supplying air to the head of the liner during the milking cycle in order to control the degree of vacuum occurring within the head.

The nozzle means may be designed to produce a spray pattern which is directed towards the barrel of the liner.

It is customary practice, during a milking cycle, alternately to apply the pneumatic pulses used for stimulating milking to pairs of teat cups of a cluster. Where the teat cups are fitted with injection nozzles for injecting treatment fluids into the head of the liners, as described in my aforementioned application, the treatment fluid is fed to the injection nozzles via a distributor on the clawpiece and the control valve for regulating the vacuum in the heads of the teat cups may conveniently be located at this distributor. If the injection nozzle is not arranged also to supply air to the head of a liner, during the milking cycle, in order to control the vacuum in the head, then it is desirable to provide non-return valves, for example, within the distributor, to avoid cross coupling of vacuum between the heads.

A pressure actuated non-return valve may be included in or adjacent the distributor for controlling admission of treatment fluid to the injection nozzle disclosed in my copending application No 0324647.7 so that the treatment fluid is retained in the delivery tube, under pressure, by the valve. The delivery tube is thus primed with treatment fluid which can be supplied in a timely manner to the teat cups at low pressure and without the addition of compressed back-up air

which has hitherto been used to ensure timely application of treatment fluid to teat cups. With such an arrangement, irrespective of whether the injection nozzle is also used, in accordance with the present invention, to supply air during the milking cycle in order to control vacuum within the teat cup heads, a safety valve is preferably included downstream of the pressure actuated non return valve to prevent treatment fluid entering the liner and contaminating the milk in the event of a control system malfunction. A suitable safety valve for this purpose, according to the invention, comprises inlet and outlet ports connectable respectively to the treatment fluid delivery tube and a tube for supplying the treatment fluid to the injection nozzles of the teat cups, a drain port, a valve member which can be actuated to connect the inlet port to the drain port or the outlet port, and means for actuating the valve member. Conveniently, the valve member is a reciprocating valve member and is mechanically coupled to a pneumatically actuated flexible diaphragm for controlling movement of the valve member between its two positions.

The safety valve provides protection against manifold valve malfunction during the milking cycle to ensure that in the event of a malfunction, which causes treatment fluid under pressure to be fed through the pressure actuated non-return valve to the distributor, is controlled by the safety valve. During the milking cycle, the safety valve is open to the drain port so that treatment fluid can flow to waste instead of risking the possibility of this treatment fluid contaminating the milk.

After completion of the milking cycle, the milking cluster at each milking point is pulled from the teats by an automatic cluster remover and the animals teats are automatically treated with disinfectant and conditioning fluid, for example, iodine or chlorohexadine and an emollient. For example, the teats may be treated automatically with treatment fluid injected within the head of the

application. Alternatively, the teat cups may be back flushed or rinsed internally via a flush valve connecting the short milk tube to the discharge end of each teat cup. When pulled from the teats, the milking cluster is designed so as to enable the short milk tubes to fall away from the center line of the cluster so that the teat cups hang downwardly and are inverted about the claw device. Consequently, liquid can escape through the heads of the teat cups. However, in both the cases where the teats and teat cups are treated with disinfectant fluid and the teat cups are rinsed, there is a risk that the fluids used may contaminate the harvested milk if they are not physically prevented from entering the short milk tube.

My copending patent application no. 0402119.2 describes a shut off valve device for preventing entry of treatment fluid into the milk tubes and consequent contamination of the harvested milk, when, subsequent to milking, treatment fluid is injected into a teat cup to cleanse the cup and teat of an animal and/or to back flush the teat cup. When used with the teat cup of the present invention, the shut off valve device may be directly connected to the discharge end of the teat cup liner or be disposed in the short milk tube connecting the teat cup to the clawpiece. Where the shut off valve device also includes a back flush nozzle, as described in application No 0402119.2, separate, flexible delivery tubes are preferably used for supplying treatment and rinse fluid to the head of the teat cup and back flush nozzle. This is instead of supplying treatment fluid to the head of the liner via a common treatment fluid passageway in the shut off valve, as described in my application No 0402119.2, which is connected to both a delivery tube for supplying fluid to the head of the teat cup and to the back flush nozzle, via a gravity controlled valve. In order to simplify the system, the back flush nozzle of the present invention is supplied with treatment fluid via a dedicated passageway in the shut off valve controlled by a pressure actuated control valve.

Each milking point in a milking parlor has a stall control unit incorporating a programmable electronic circuit board controlling solenoid valves which, in turn, selectively control the supply of treatment fluids, water, compressed air and

vacuum to the milking cluster from a manifold assembly delivering these fluids to the individual milking points from common sources of supply. The programmable electronic circuit board can be programmed via a local network. The stall control unit selectively delivers the fluids to a distributor mounted on the clawpiece of the associated cluster. The distributor distributes the fluids to the individual teat cups, each of which, in accordance with a preferred embodiment of the present invention, may incorporate an injection nozzle which enables the vacuum in the head of the teat cup liner to be regulated during the milking cycle and, subsequently, enables treatment fluid to be injected into the head of the liner. A shut off valve constructed in accordance with the present invention is installed in each short milk tube connecting a teat cup to the clawpiece. This shut off valve incorporates a diaphragm which, when supplied with air under pressure closes and blocks the short milk tube during the cleansing cycle. It is opened again, following completion of the cleansing cycle by the application of vacuum. A nozzle may be incorporated with the shut off valve to flush clean the discharge end of the liner, and the shut off valve incorporates a bleed valve to allow liquid to drain from the liner if the associated teat cup becomes entangled and fails to invert upon take off from a teat.

According to another aspect, the invention consists in a stall control unit comprising valves for selectively controlling the supply of fluids from a manifold assembly of the milking equipment to the teat cups of a milking cluster, whereby air, preferably at ambient pressure, is supplied to the head of the liner of each teat cup during the milking cycle in order to regulate the vacuum in the head of the liner, and treatment fluid is applied to an animal's teat engaged with each teat cup at completion of the milking cycle and during a cleansing cycle in order to disinfect the teat and cleanse the teat cup for the next animal. Preferably, the stall control unit also includes valve means for selectively applying compressed [illegible]

The invention is devised to enable users to benefit from improved animal health, efficient use of teat care products, consistent and controlled application of the milking process and significant labor savings due to reduced workload, improved animal health and increased animal throughputs in the milking parlor.

The programmable electronic circuit board in each stall control unit is designed to control the valves of the stall control unit, the timing of their actuation and, hence, the quantity of fluids supplied to the distributor of the clawpiece. The stall control unit may include means for monitoring system performance, pressure and vacuum levels and system status, etc.

At the completion of the milking cycle, a suitable control signal which may be derived from the milking equipment, for example, it can be obtained from the milk flow meter or automatic cluster remover fitted at a respective milking point, is fed to the programmable electronic circuit board. This initiates a change in pneumatic signals supplied to the shut off valves connected to the teat cups such that the vacuum signal applied to the diaphragm of each shut off valve is reversed to an air pressure signal thereby closing the valve. These same signals may also operate the safety valve, if fitted to the cluster, so as to direct treatment fluid from the drain safety position to the injection nozzles. When the shut off valves are actuated treatment fluid fed via the distributor of the clawpiece is injected through the injection nozzles in the heads of the liners of the teat cups at the point of or during removal of the teat cups from the animal. The animal's teats are thereby coated with treatment fluid.

After the milking cluster has been removed from the teats and the teat cups hang downwardly about the clawpiece, their liners are alternately flushed with water and compressed air injected through the back flush nozzles of the shut off valves in order to remove milk residue, soil and traces of the disinfectant and conditioning fluid from the liners. Portions of the water and compressed air flow past a non-return valve within the distributor to flush the heads of the liners and the injection nozzles in the teat cup heads. Thereafter, treatment fluid is injected into the discharge ends of the liners and/or the short milk tubes via the back flushing nozzles of the shut off valves to rinse and clean the liners. Again,

a portion of the treatment flows through the non-return valve within the distributor to flush the head nozzles. Following this flushing step, there may be a pause in the cleaning cycle to allow time for contact of the treatment fluid with the liners. In the last stage of the cleansing cycle, water and compressed air are alternately injected through the head nozzles and the back flush nozzles to rinse away treatment fluid, compressed air being the final fluid to be injected in order to dry the liner and nozzles. Upon completion of the cleansing cycle, the pressure signal applied to each shut off valve and also the safety valve, if fitted, is reversed to a vacuum signal, thereby opening the valves and returning to the safety valve to a fail-safe position, whereafter the next milking cycle can be commenced.

In the event of a teat cup of a cluster becoming entangled and being held with its liner in a head up attitude, the non-return bleed valve of the associated shut off valve allows liquid to drain from the liner.

In order that the present invention may be more readily understood, reference will now be made to the accompanying drawings, in which:-

Figure 1 is an axial section through a teat cup and associated shut off valve device according to the invention, when in the milking position, with the valve device being shown in an unactuated condition,

Figure 2 is a view similar to Figure 1 showing the valve device in an actuated condition,

Figure 3 is a view similar to Figure 2 showing the valve device and teat cup in the inverted position which it is designed to adopt after take off,

Figures 4 and 5 are axial sections of the shut off valve shown in Figures 1, 2 and 3 on a larger scale,

Figures 6 and 7 are axial sections similar to Figures 4 and 5 and showing a modification,

controls the delivery of treatment fluids and pneumatic signals to the teat cups, shut off valves and safety valve of a milking cluster,

Figure 10 is a schematic fluid circuit diagram similar to Figure 9 and including an additional valve for controlling the supply of air at atmospheric pressure to the heads of the liners for regulating the vacuum in the liner heads, and

Figure 11 is a timing chart illustrating an example of the sequence and time periods for the supply of disinfecting, flushing fluids and pneumatic signals to the teat cups, shut off valves and safety valve during the cleansing cycle of a milking cluster.

The teat cup illustrated in Figures 1, 2 and 3 of the accompanying drawings is one of four similar teat cups of a milking cluster used for milking a cow and which is connected to automatic milking equipment. Each teat cup 1 comprises a hollow cylindrical shell 2 supporting a flexible liner 3 in spaced relation with the shell. The liner is sealed to the shell at the bottom, discharge end 4 of the cup and, at the top or head end 5, has a head portion 6 which engages about the outside of the shell in order to seal the head of the liner to the shell. The head of the liner is formed with an opening 7 permitting access to the interior of the liner. Between the top of the barrel 8 of the liner and the opening 7, the head of the liner is formed with an internal annular cavity 9 which, when an animal's teat is inserted into the cup through the opening 7, forms a void or space 10 between the side of the teat and the head. At the discharge end 4 of the cup, the liner communicates with a flexible, short milk tube 11 connecting the teat cup to the clawpiece (not shown) of the milking cluster and, via which, vacuum is applied to the inside of the liner for removing from the cup, milk discharged by the teat during the milking cycle. By way of example, the shell 2 may be produced from stainless steel or plastics material and the liner 3 may be moulded from resilient plastics, synthetic rubber or silicone.

As will be appreciated by those skilled in the art, the cup 1 is fitted with suitable means (not shown) for connecting the space 12 between the shell 2 and the liner 3, via the clawpiece, to the associated milking point which has control

means for alternately supplying vacuum pulses and venting the space 12 to atmosphere in order to cause the liner 3 to flex against the teat and stimulate a milking operation. The vacuum is supplied from a common source connected to the milking point by the manifold assembly of the milking equipment.

Extending into the head 6 of the liner, and into the cavity 9 on the inside of the liner, is an injection nozzle 13 which is integral with a supply tube 14 for delivering fluid to the nozzle. This tube extends down the outside of the shell 2 where it is enclosed in a housing 15 attaching it to the outside of the shell. Its distal or inlet end projects from the housing 15 and is connected to a flexible delivery tube 16. The distal end of the latter is coupled to a control valve system, as more fully described below, so as to be selectively connectable to supplies of compressed air and disinfectant.

The injection nozzle 13 is designed so as to direct fluid sprayed from the nozzle inwardly and downwardly into the interior of the barrel 8 of the liner, as viewed in Figures 1 and 2.

When the teat cups have been fitted to a cow's udder and the milking equipment is being operated in the milking cycle, vacuum is applied to each short milk tube 11 in order to extract, from the associated teat cup, milk discharged into the liner from the engaged teat. This vacuum is also applied, via the liner, to the void 10 between the engaged teat and the head 6 of the liner and serves to capture the cup on the teat. Vacuum and atmospheric pressure are then alternately applied in pulses to the space 12 between the liner and the shell in order to flex the liner against the teat and stimulate milking. Milk discharged by the teat into the barrel 8 of the liner is extracted from the liner, via its discharge end 4, for delivery to a collecting vessel of the milking equipment. During this milking cycle, clean filtered air at atmospheric pressure is admitted into the head of the liner, via the delivery tube and the injection nozzle 13, under [illegible]

The discharge end 4 of each cup liner is coupled to the associated short milk tube 11 by a shut off valve device 20 which is best seen in Figures 4 and 5. This device comprises a valve body 21 having a milk passageway 22 therethrough, opposite ends of which terminate in spigots 23,24 connecting the milk passageway to the discharge end 4 of the teat cup liner and the short milk tube, respectively. The valve body 21 has a cylindrical valve chamber 25 to one side of the milk passageway 22 which is connected to the latter via a circular opening 26. A valve member 27 moulded from flexible membrane material, such as, rubber, silicone or other elastomeric material, forms a seal between the chamber 25 and the opening 26. The membrane valve member 27 is moulded in a cylindrical cap-like shape having its cap portion 27a projecting into the chamber 25 and the cavity in the cap portion facing the milk passageway 22, when in the unactuated position shown in Figures 1 and 4. This valve member is retained in position by an outwardly projecting radial flange 28 about the mouth of its cavity trapped between mating parts of the valve body. The valve chamber 25 is selectively connectable to a source of pneumatic pressure or vacuum for controlling the valve member 27 via a port 29 in the wall of the chamber which has its external end connected to a flexible pneumatic tube 30 coupling the port to the source of pneumatic pressure or vacuum. A pressure sensor (not shown) may monitor the pressure in the valve chamber 25 for detecting possible malfunction of the membrane valve member 27. A recess 31 is formed about the internal wall of the milk passageway 22 adjacent the valve chamber 25 for locating the valve member 27 when the latter is extended across the passageway in its actuated position.

Formed in the valve body is a treatment fluid passageway 32 having its inlet end 33 connected to a treatment fluid supply tube 34 and its discharge end connected to a back flush nozzle 35. The back flush nozzle is inclined to the axis of the milk passageway so as to direct flushing or rinsing fluid towards the interior of the liner 3 and is connected to the passageway 22 via a pressure-actuated valve 36.

Formed through the wall of the valve body 21 opposite the back flush nozzle 35 and immediately upstream of the location recess 31 is a drain port 37 for enabling fluid trapped by the shut-off valve to drain from the valve. This port is controlled by a non-return flap valve 38 mounted on the valve body at the external end of the drain port 37.

The spigot 23 at the inlet end of the milk passageway 22 is an interference fit in the discharge end 4 of the flexible liner 3 of the teat cup 1 in order to couple the valve device to the teat cup.

The embodiment of shut-off valve device 40 illustrated in Figures 6 and 7 is constructed and adapted to operate similarly to the shut-off valve device 20 of Figures 4 and 5 except that the pressure actuated valve 41 connecting the treatment fluid passageway 32 to the back flush nozzle 35 is of modified design. Instead of being a spring controlled ball valve, the valve 41 is formed by a pair of resilient lips 42 projecting into the nozzle 35 from the discharge end of the treatment fluid passageway 32 with the free ends of the lips being resiliently urged into contact in order normally to shut-off fluid flow between the passageway 32 and the nozzle 35. However, when the fluid in the passageway 32 exceeds a predetermined pressure, the lips 42 are urged apart by the fluid pressure in order to permit fluid to flow from the passageway 32 into the nozzle 35 for injection into the milk passage 22.

Treatment fluids for sanitising, rinsing and drying, such as disinfecting and conditioning liquid, water and compressed air, as well as compressed air and vacuum for providing pneumatic control signals, are supplied to each milking point, from common sources, by a manifold system. At each milking point, a stall control unit incorporating solenoid operated valves selectively supplies the fluids from the manifold system to the teat cups 1 and shut-off valves 20,40 via a distributor mounted on the clawpiece and flexible tubing connecting the distributor [illegible] The clawpiece also [illegible]

generating and supplying the pneumatic milking pulses is conventional and, since it forms no part of the present invention, it will not be described in detail.

Figure 9 illustrates one embodiment of a valve controlled fluid system for regulating the supply of fluids and pneumatic control signals to the distributor, teat cups 1 and shut-off valves 20,40 of a milking cluster embodying the invention. The system has three outlet ports 50,51,52 connected to the distributor and via which (i) compressed air and vacuum control signals are supplied to the four shut-off valves 20,40 of the cluster, (ii) disinfectant fluids and compressed air are supplied to the injection nozzles 13 in the heads of the four teat cups and (iii) rinse fluids, water and compressed air are supplied to the back flush nozzles 35 of the four shut off valves. Each port 50,51,52 supplies its fluid to the associated devices via the distributor mounted on the clawpiece. The selective control of the supply of fluids to the outlet ports 50,51,52 is by means of seven solenoid operated valves 53-58 actuated under the control of a programmable electronic circuit board of the stall control unit, non-return valves 59,60,61, and a safety valve 62. Compressed air at lower pressure, for example 1 bar, and vacuum are alternately supplied to the outlet port 50 under the control of the three-way valve 53 having inputs connected to compressed air and vacuum lines 63,64 of the manifold assembly and an outlet port connected to the port 50. The two-way valve 54 has an inlet port connected to the compressed air line 63 and an outlet port connected, via the non-return valve 59, to the port 51. The supply of disinfecting liquid to the port 51 is controlled by the valve 55 which has an inlet port connected to the supply line 65 of disinfecting liquid in the manifold assembly. An outlet port of the valve 55 is connected, via the pressure controlled non-return valve 60 and the safety valve 62, to the port 51. A second outlet port serves as a bleed port. The valve 56 controls the supply of rinse liquid to the ports 51,52. It has an inlet port connected to the rinse liquid supply line 66 of the manifold, and an outlet port connected to the system port 52 and, via the non-return valve 61, to the system port 51. A second of the valve ports serves as a bleed port. The control of water and compressed air at a higher pressure, for example, 6 bar, to the system ports 51,52 is by means of

valves 57,58 which have inlet ports connected to the water and compressed air manifold supplies 67,68 and both of which have outlet ports connected to the outlet port of the valve 56. The second outlet port of the valve 57 serves as a bleed port.

In the fluid control system illustrated in Figure 9, because the supply line for disinfectant fluid is maintained primed up to the inlet of the pressure actuated non-return valve 60, the safety valve 62 is inserted in this supply line downstream of the pressure actuated valve 60 and between the system port 51 and the junction of the three non-return valves 59-61. This safety valve 62 is pneumatically operated under the control of the valve 54a having its inlet port connected to the low pressure compressed air line 63 and its outlet port connected to the compressed air inlet port of the safety valve. During the milking cycle, the safety valve opens a drain port through which the disinfecting may flow to waste should there be a malfunction in the system upstream of the safety valve. One embodiment of the latter is illustrated in Figure 8 and comprises a valve chamber 70 having an inlet port 71 connected to the outlet port of the pressure actuated non-return valve 60, an outlet port 72 connected to the system port 51 and a drain port 73. A reciprocable valve member 74 having valve seals 75 is movable between two positions in which it alternately seals the outlet port 72 and the drain port 73. Movement of the valve member is controlled by a resilient diaphragm 76 mounted in a pneumatic chamber 77 and connected to the valve member by a valve rod 78 coaxial with the outlet port 72 and slidable through a seal 79 in the valve body between the pneumatic chamber and the outlet port. The resilient diaphragm is sealed at its peripheries to the valve body 80 and, on the side of the diaphragm remote from the valve chamber 70, the pneumatic chamber 77 has an inlet port 81 connectable to the outlet port of the valve 54a. On the side of the diaphragm adjacent the valve chamber, the pneumatic chamber [illegible]

sealing engagement with the drain port 73 so that disinfectant and other treatment fluid can be fed through the inlet port 71 and the outlet port 72 to the system port 51.

When the teat cups are attached to the teats of a cow for milking, the teat cups are in the position generally illustrated in Figures 1 and 2 with their heads 6 uppermost. Milking is stimulated conventionally by applying pneumatic pulses to the space 12 between the shell 2 and the liner 3 of each teat cup, via the claw device, the pulses being alternately applied to pairs of the teat cups. During the milking cycle, the shut-off valves 20,40 are in the open position, as illustrated in Figures 1 and 4, and the safety valve 62 is in the closed position, as illustrated in Figure 8 in which the outlet port 72 is sealed and in which any flow of treatment fluid through the inlet port 71 is drained to waste through the drain port 73. Milk is extracted from each teat cup, via the associated shut off valve and the short milk tube 11, by vacuum applied through the claw device. This vacuum retains the non-return flap valves 38 in the closed condition so that milk cannot bleed through the drain port 37. The shut-off valves 20,40 are retained in the open position and the safety valve 62 is retained in the closed position via the valve 53 applying vacuum to the port 50.

When the milking cycle is to be terminated, which is detected by a milk flow meter of the stall control unit as a reduction of milk flow below a predetermined level, the automatic cluster remover is signaled to take off the cluster from the cows udder and, also, the programmable electronic circuit board of the stall control unit is signaled to commence the cleansing cycle. Referring also to the timing chart of Figure 11, following a preselected time delay T1 at the start of the cleansing cycle to permit vacuum within the liner of the teat cups to decay, the valves 54a and 55 are actuated, just before take off, to open the safety valve 62 and supply disinfecting liquid to the system port 51 for a period T2 at a pressure predetermined by the pressure actuated non-return valve 60. Because the supply line is primed with disinfectant up to the valve 60, the disinfectant is supplied to the port 51 and distributed to the injection nozzles 13 in the liner heads of the teat cups with minimum delay so as to inject disinfectant

into the void 10 about each teat. The injection of this fluid is timed to occur upon or immediately prior to actuation of the cluster remover. Removal of the cluster from the teats may be aided by delivering pulses and/or a charge T3 of low pressure compressed air, via valve 54, to the injection nozzles 13 and into the void 10 in each cup, as the cups are being removed. In any event, as the cups are removed, the disinfectant fluid is sprayed, spread or wiped down the outside of each teat, thus ensuring that the whole teat is hygienically coated with disinfecting liquid. Because the fluid is injected at low pressure and because it is contained within the voids 10 as the cups are removed from the teats, this alleviates the problem of fluid vapor or mist in the surrounding environment and consequent health risks. Upon closing of the valve 55 at the end of the period T2, which occurs prior to full take off, the valve 53 is actuated to supply compressed air to the system port 50. This applies compressed air to the shut-off valves 20,40 to actuate or extend the membrane valve members 27. As illustrated in Figures 2 and 5, upon the application of air pressure, each valve member is turned inside out so as to project across the milk passageway 22 and is expanded or inflated so as to seal with the recess 31. This blocks the associated milk passageway and shuts-off fluid flow therethrough for the full cleansing cycle. Preferably, each shut-off valve has a pressure sensor connected to monitor the membrane valve member and sense whether or not the valve member has operated correctly. If it has not, the associated milking cluster will be shut down in conjunction with the actuation of an alarm.

Following actuation of the shut off valves 20,40 and take off, the teat cups 1 naturally fall into a position in which they hang downwardly from the short milk tubes 11 and in an inverted position with their heads downwardly, as illustrated in Figure 3. When the teat cups fall into this downwardly hanging position, pulses of water and compressed air are alternately fed to the system port 52 by [illegible]

flow through the non-return valve 61 to the system port 51 to flush disinfectant from the injection nozzles 13 and the heads of the liners. Thereafter, the valve 56 opens to supply rinse liquid, via the port 52 and distributor to the back flush nozzles 35 for a period T9 to disinfect and rinse the liner. Again, a proportion of this fluid flows through the non-return valve 61 to flush through the injector nozzles 13 in the liner heads. Following injection of the rinse liquid, a delay T10 is included in the cycle to enable contact time of the disinfecting rinse liquid with the liners, whereafter the valves 57,58 are alternately opened and closed to provide for the supply of water and compressed air pulses T11-T34 to the back flush nozzles 35 for injection into the liners so as to rinse away the disinfectant. The injection of the water and compressed air pulses at this stage is repeated for a predetermined number of times dependent on rinsing requirements. The last pulse T34 is always a compressed air pulse in order to inject air into the teat cups to dry the liners and injectors. Following the final compressed air pulse, the valve 53 is actuated to remove the supply of compressed air from the port 50 and apply vacuum thereto in order to return the membrane valve members 27 into their respective valve chambers and open the shut-off valves 20,40 in readiness for the next milking cycle.

Because vacuum is no longer applied to the milk passageways 22 to withdraw milk from the teat cups when the milking cycle is terminated, the pressure in the milk passageways above the extended membrane valve members 27 returns to atmospheric pressure and the flap valves 38 are free to open. This provides the facility for any fluid to drain away if a teat cup, for some reason, becomes entangled and is prevented from falling over upon take off and is held in a partially upright position.

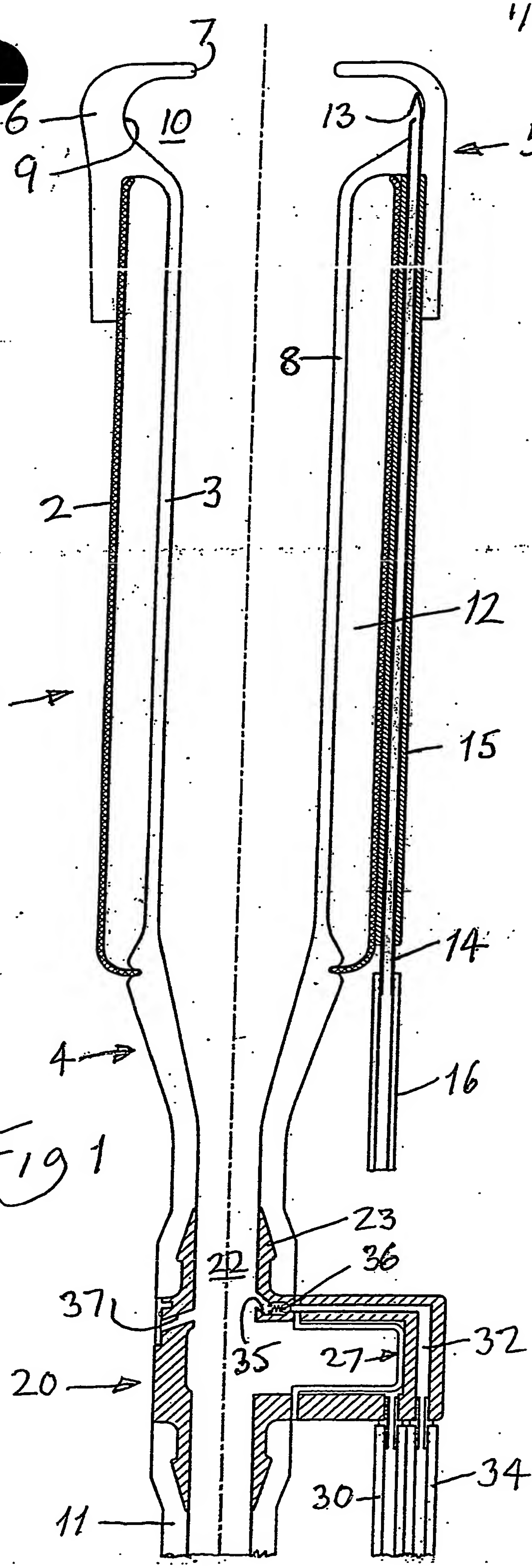
Figure 10 illustrates the fluid circuit diagram and control valves for a stall control unit which is adapted to control the degree of vacuum applied to the liner heads 6 of the teat cups during the milking cycle. The fluid circuit is similar to that described with reference to Figure 9 except for the omission of the safety valve 62 and its control valve 54<u>a</u> and the addition of a filtered air supply 90 which is connected, via a vacuum regulating valve 91 and a non-return valve 92

to the system port 51 through which fluid is distributed to the injection nozzles 13 in the liner heads of the teat cluster. The filtered air supply is preferably derived from ambient air at atmospheric pressure which is filtered through a food grade filtration unit to reduce the risk of contaminating the milk. During the milking cycle, this is applied to the inlet port of the valve 91 which is responsive to differential pressure. Its outlet port is subject to the level of the vacuum in the cavities 10 in the heads of the liners. When excessive vacuum occurs in one or more of the cavities, the resultant differential pressure opens the valve 91 so that air at atmospheric pressure is drawn into the cavity or cavities to reduce the vacuum to the desired predetermined level, thereby to regulate the vacuum in the liner heads. The benefit of this is that the level of the vacuum is controlled in the area of the heads 6 to prevent the risk of liner creep up the teat which results in the restriction of blood flow in the animal's teats and consequent discomfort, poor milk let down and physical damage to the teat end. The regulation of the vacuum in the heads of the liners enables precise control over the milking characteristics of the teat cup.

In the fluid control circuits schematically illustrated in Figures 9 and 10, the solenoid operated control valves 53-58 are located in the stall control unit, as indicated by the broken lines 100, whilst the associated non-return and safety valves 59-62 are located at the distributor mounted on the clawpiece, as indicated by the broken lines 101. Alternatively, both the solenoid operated control valves and the non-return valves may be mounted remotely from the milking cluster, at the stall control unit.

Whilst a particular embodiment has been described, it will be understood that modifications can be made without departing from the scope of the invention. For example, the shut off valve devices 20,40 may be modified to omit the back flush nozzles 35, associated valves and delivery tubes, and rinsing and drying may be achieved simply by supplying rinsing fluid and compressed [illegible]

Moreover, a shut-off valve device constructed similarly to the shut-off valves 20,40 may be installed in the long milk tube in order to provide a conventional back flushing function. When such a valve is installed in the long milk tube it may be advantageous to replace the flap controlled bleed valve 37,38 by a mechanically actuated bleed valve. This may be achieved by altering the design so as to provide an inward projection on the flap valve and by reposition it slightly closer to the diaphragm valve member 27. The effect of this is that, as the diaphragm valve member is operated to block the milk passageway 22, it will contact the projection on the flap valve and physically urge the valve into the open position.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6
10
9
13
5
8
2
3
12
1
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22
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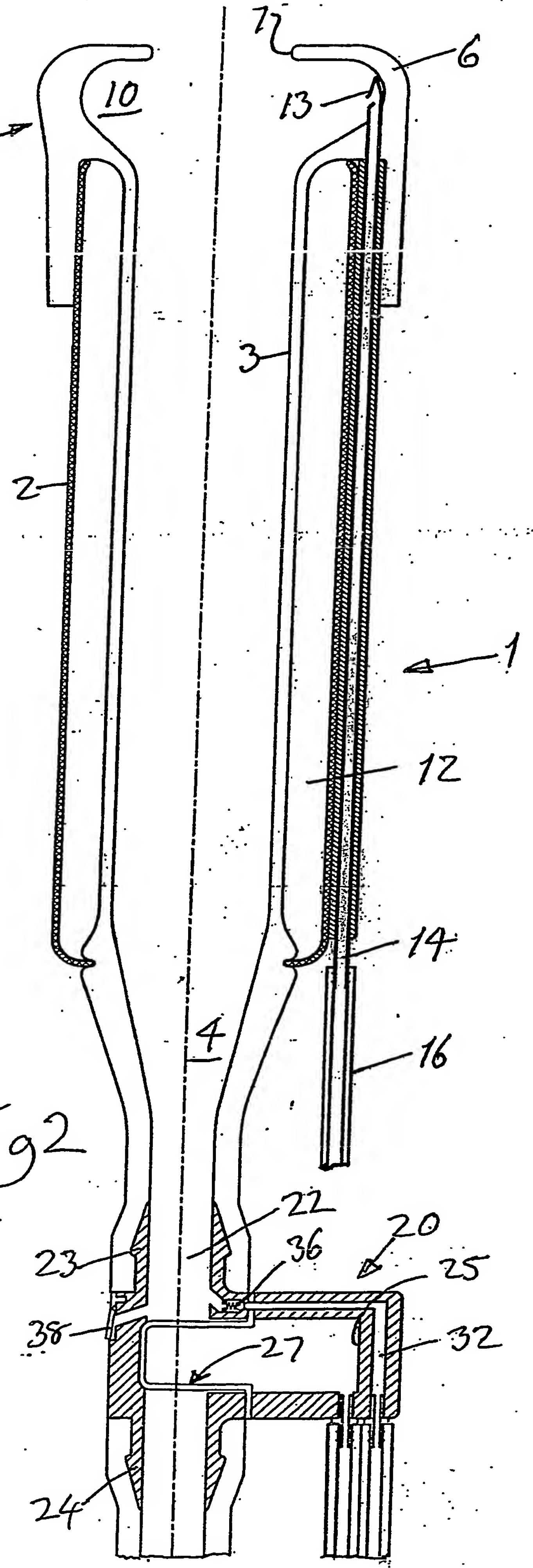
30
11

Fig 1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38
32
27
24

Fig 2

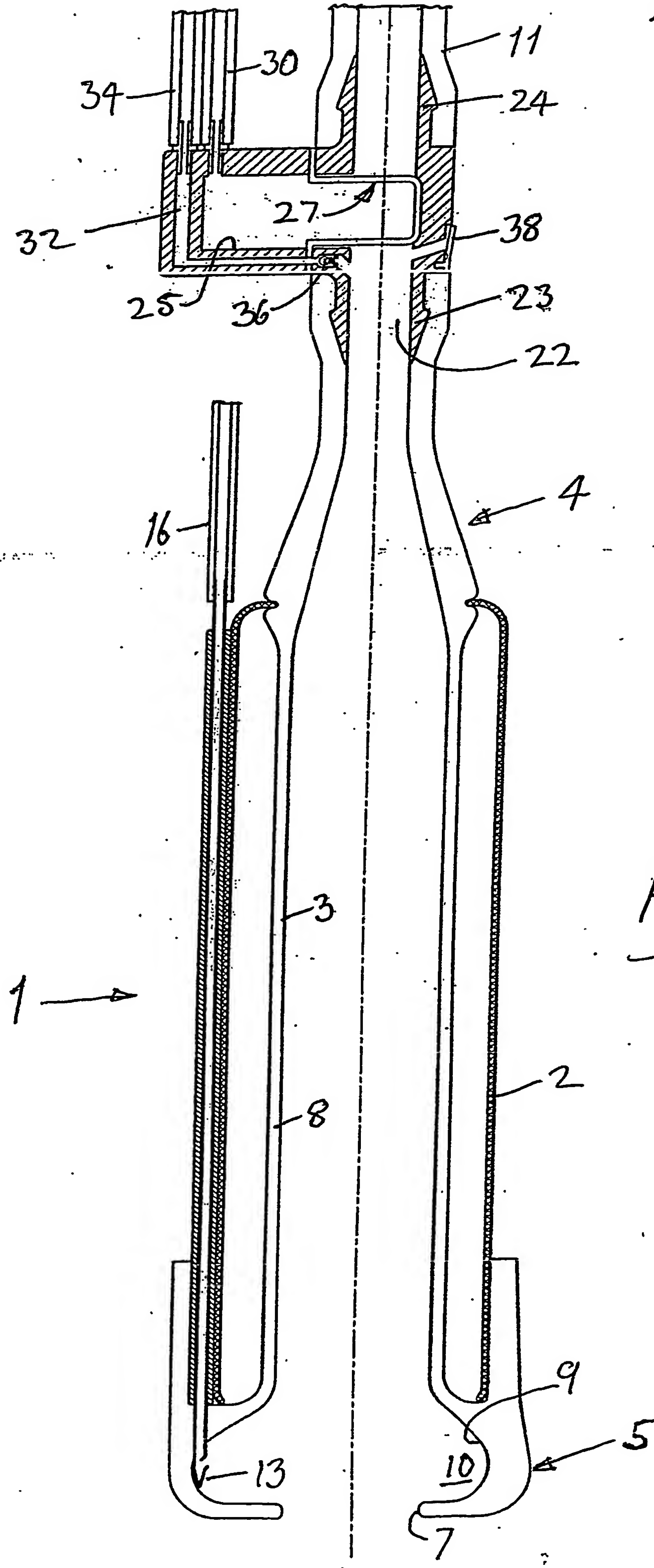
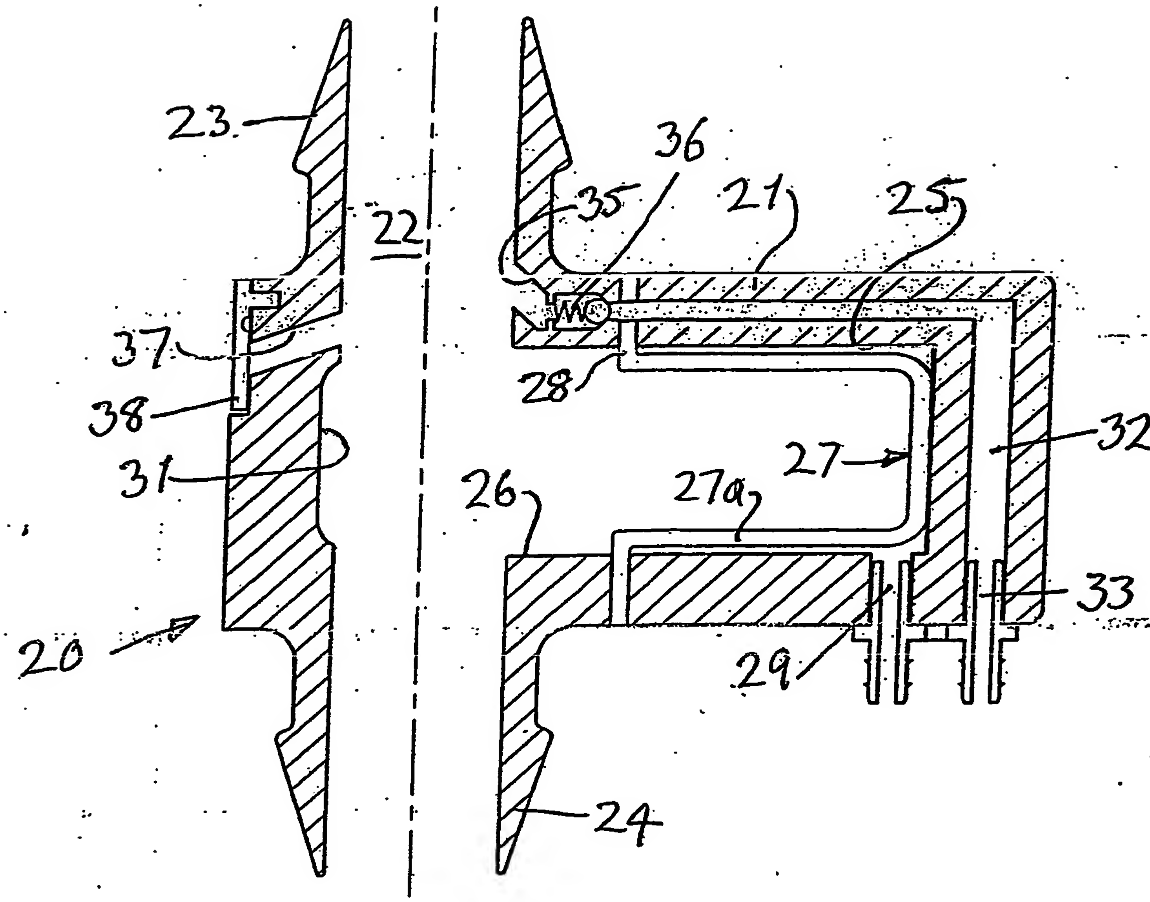


Fig 3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21
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37
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38
32
31
27
27a
26
33
20
29
24

Fig 4

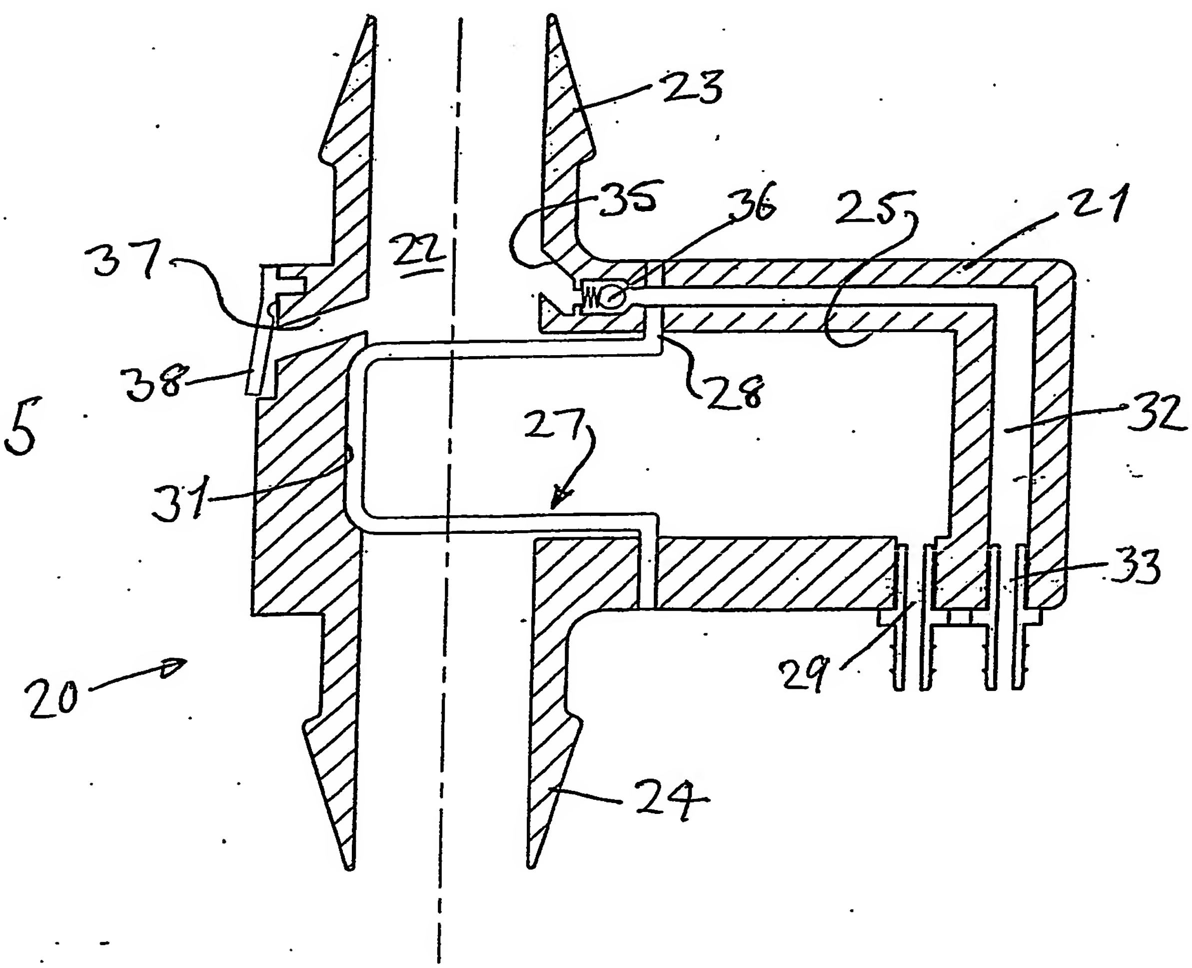
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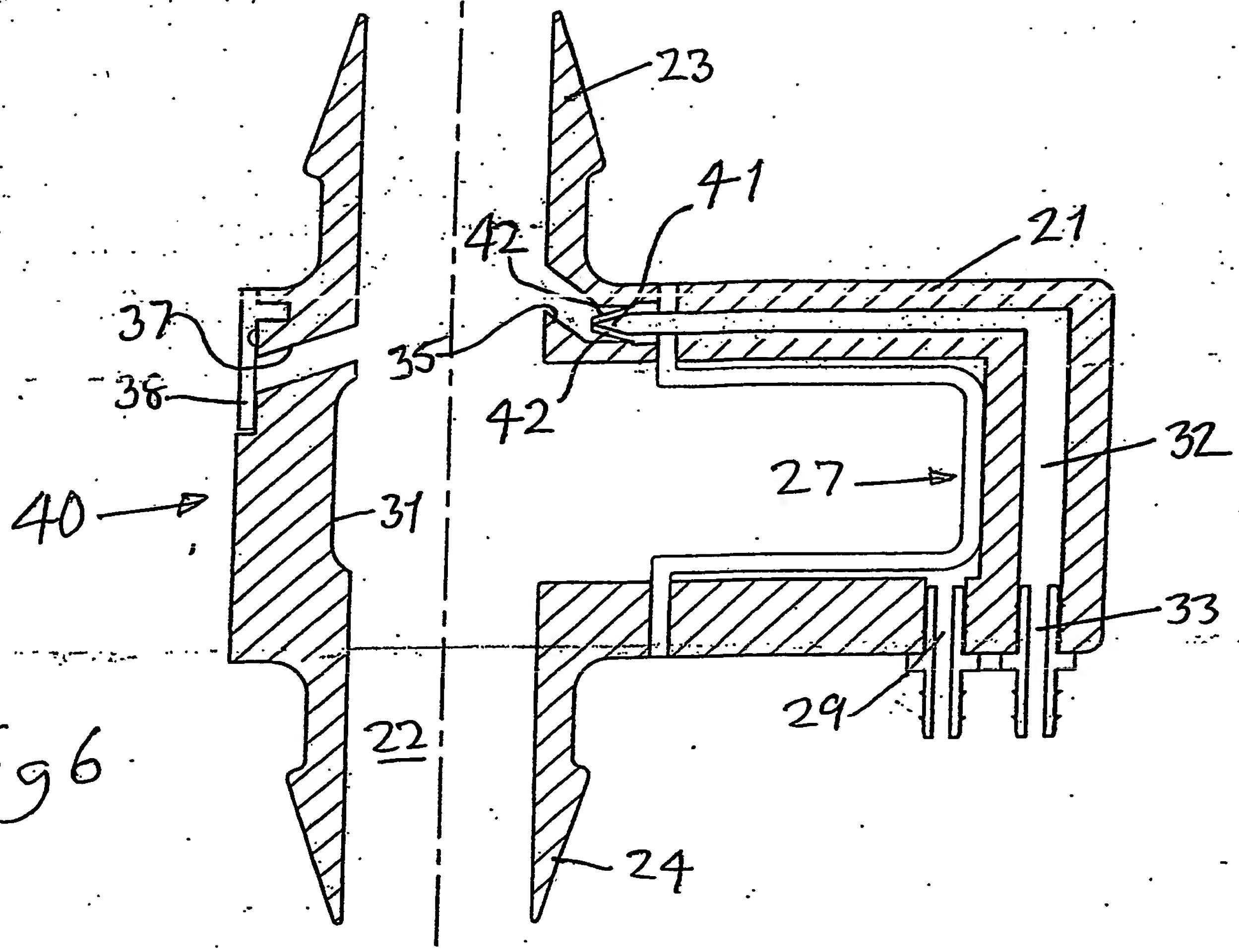
Fig 5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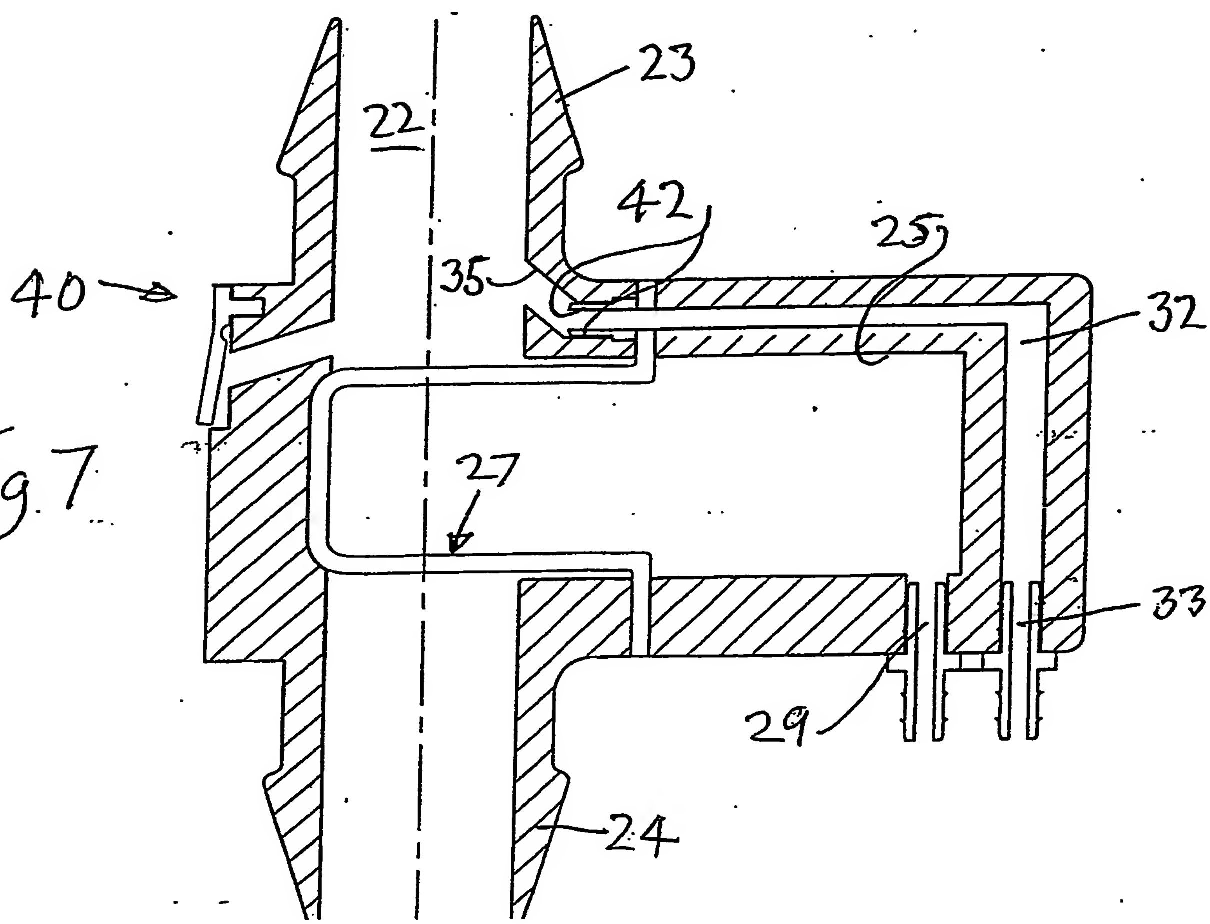
27
40
31
33
29
22
24

Fig 6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40
35
32
27
33
29
24

Fig 7

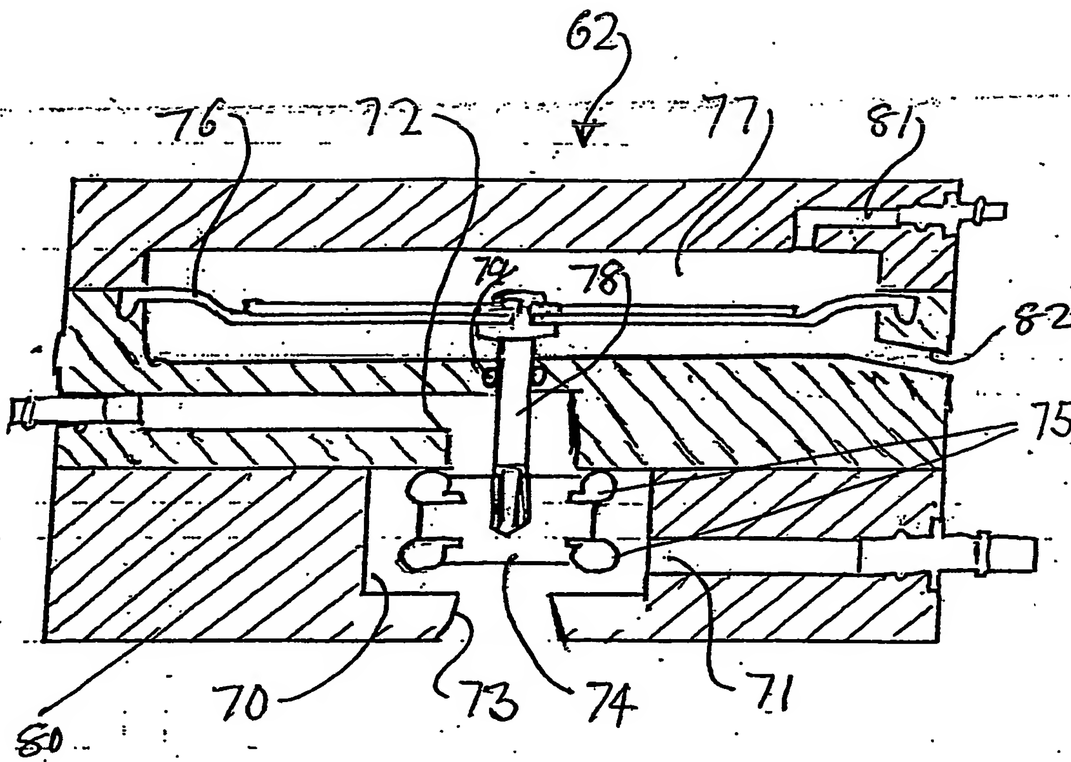
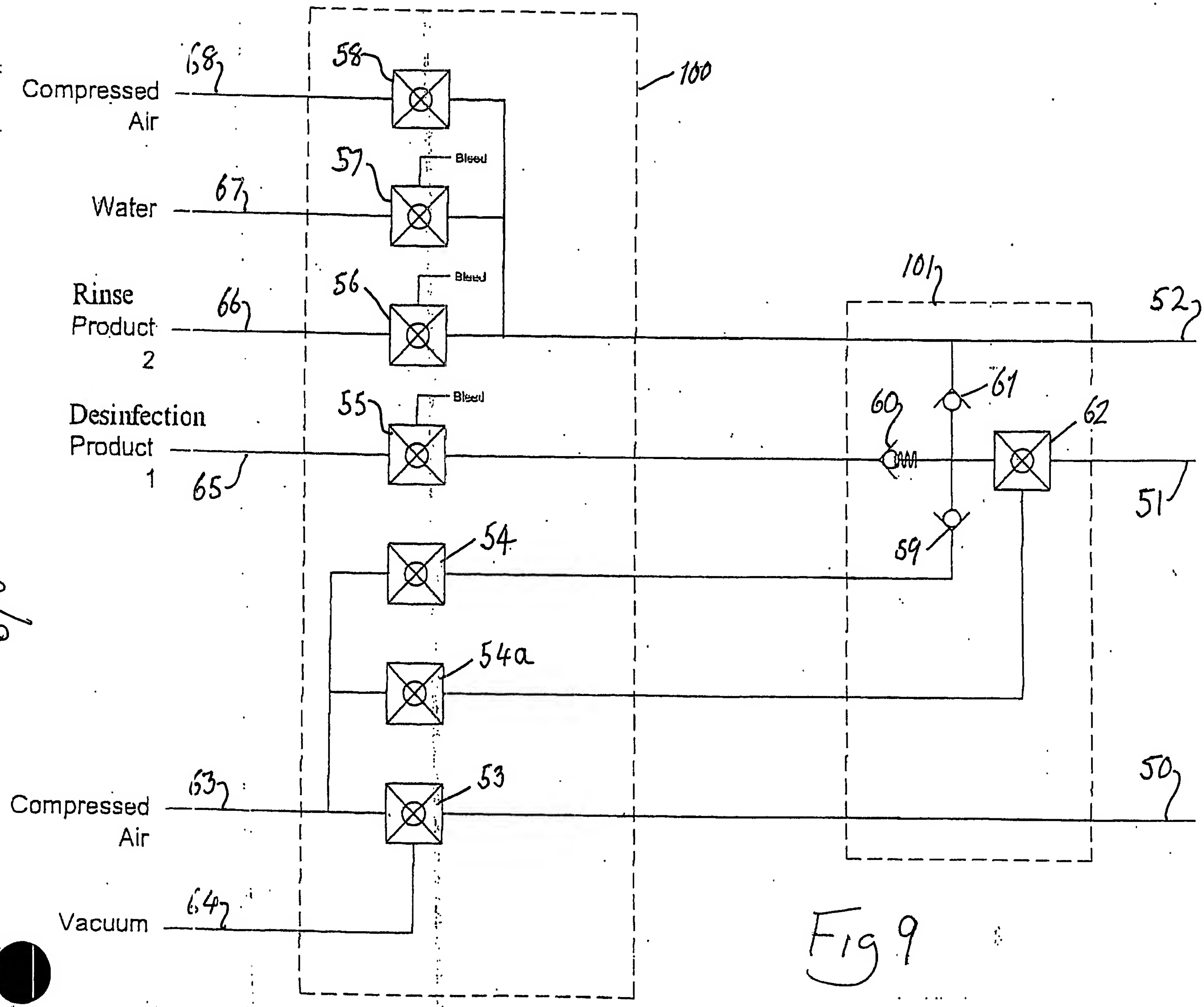


Fig 8



68
Compressed
Air
67
Water
66
Rinse
Product
2
65
Desinfection
Product
1
63
Compressed
Air
64
Vacuum
58
57
56
55
54
54a
53
Bleed
Bleed
Bleed
100
101
60
61
59
62
52
51
50

Fig 9

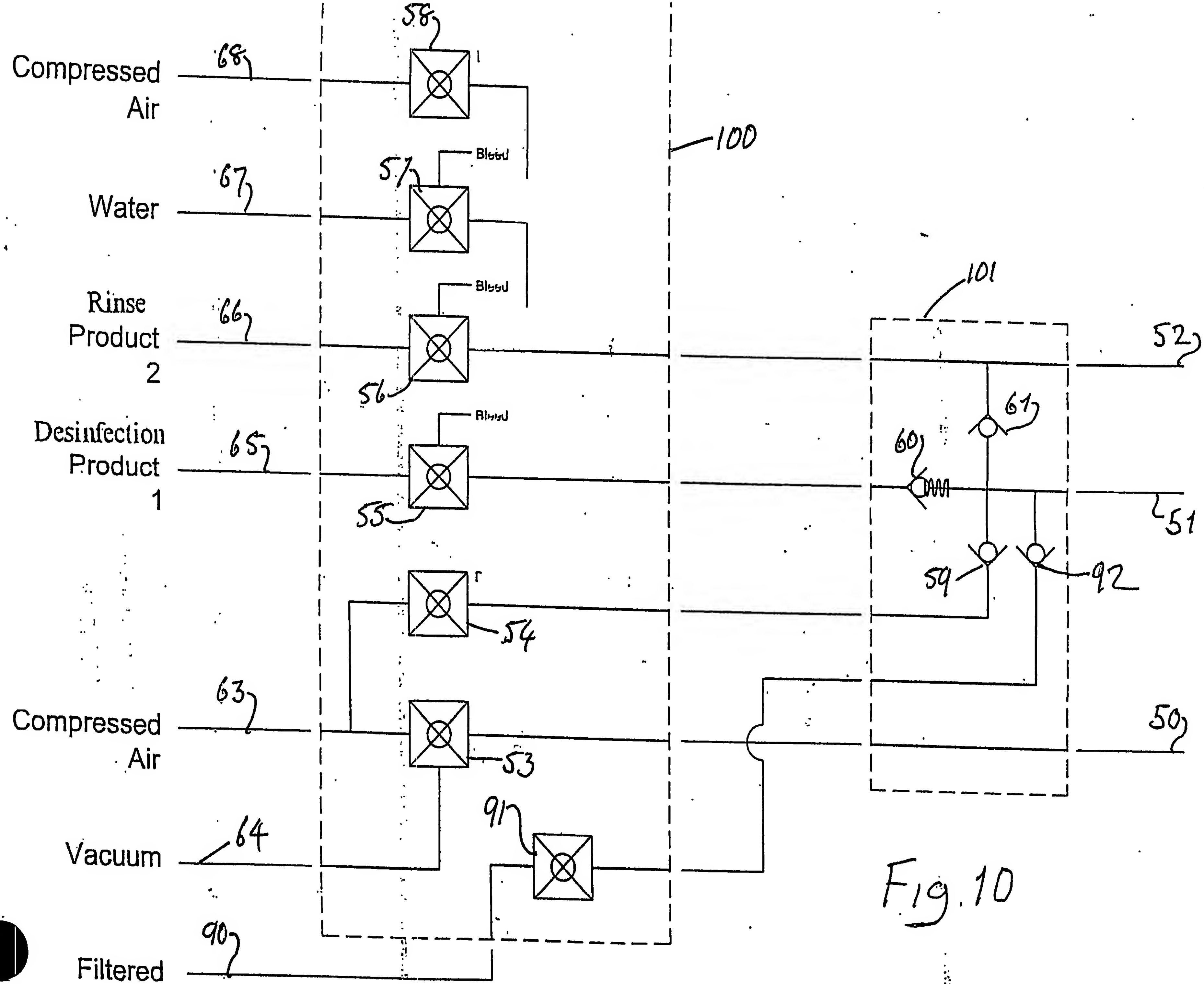

Compressed Air
68
Water
67
Rinse Product 2
66
Desinfection Product 1
65
Compressed Air
63
Vacuum
64
Filtered
90
58
57
56
55
54
53
91
Bleed
Bleed
Bleed
100
101
60
61
59
92
52
51
50

Fig. 10

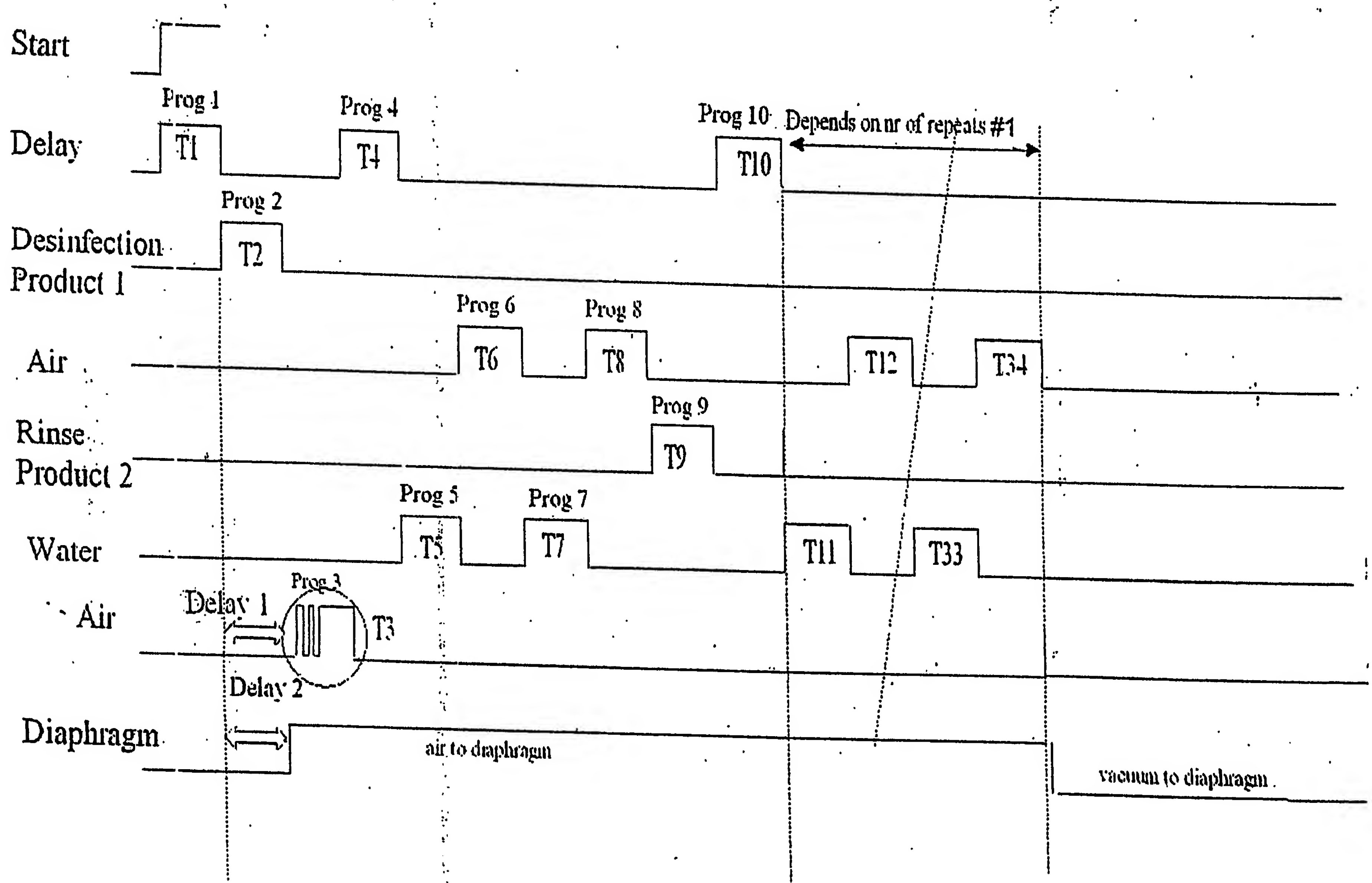

Start
Delay
Desinfection
Product 1
Air
Rinse
Product 2
Water
Air
Diaphragm
Prog 1
T1
Prog 2
T2
Prog 3
T3
Delay 1
Delay 2
Prog 4
T4
Prog 5
T5
Prog 6
T6
Prog 7
T7
Prog 8
T8
Prog 9
T9
Prog 10
T10
Depends on nr of repeats #1
T11
T12
T33
T34
air to diaphragm
vacuum to diaphragm

Fig 11